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MARINE/CONTINENTAL HISTORY OF AEROSOLS AT SAN NICOLAS ISLAND DU--ETC(U)
APR 79 J ROSENTHAL , T E BATTALINO
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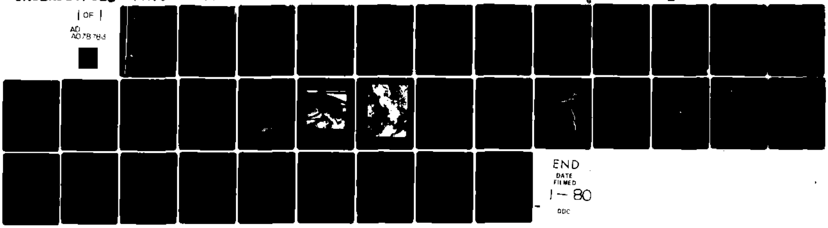

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SUMMARY
MARINE/CONTINENTAL HISTORY OF AEROSOLS AT SAN NICOLAS ISLAND DURING CEWCOM-78 AND OSP III

(PREPARED FOR OPTICAL SIGNATURES PROGRAM (OSP) NAVAL WEAPONS CENTER, and ELECTRO-OPTICAL METEOROLOGY (EOMET) PROGRAM, NAVAL OCEAN SYSTEMS CENTER)

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APRIL 1979

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This report was prepared by J. Rosenthal, T. E. Battalino, and H. Hendon, Geophysics Division, PACMISTESTCEN, and V. R. Noonkester, Electromagnetic Systems Division, NOSC.

Mr. D. A. Lea, Associate Geophysics Officer; Dr. T. C. Lockhart, Associate Range Operations Officer, and Mr. W. L. Miller, Associate Director, Range Directorate, have reviewed this report for publication.

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Technical Director	*Acting Commander Pacific Missile Test Center*

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1. Enclosed is a PACMISTESTCEN Summary Document entitled "Marine/Continental History of Aerosols At San Nicolas Island During CEWCOM-78 and OSP III." The report summarizes detailed day by day analyses of meteorological conditions during measurement periods sponsored by the Optical Signatures Program (OSP), NWC, China Lake, CA, and the Electrooptical Meteorology (EOMET) Program, NOSC, San Diego, CA. A brief "EXECUTIVE SUMMARY" is provided at the beginning of this report.

2. A second more complete document of the same title has been published for a limited distribution for those desiring detailed analysis of each day of CEWCOM/OSP III covering 25 April – 1 June 1978. If desired, a copy of this complete document can be obtained by contacting Dr. Jon Wunderlich, OSP Program Manager, Code 39403, Naval Weapons Center, China Lake, CA 93555 or Mr. Jay Rosenthal, Code 3253, Pacific Missile Test Center, Point Mugu, CA 93042.

A. M. Torres

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Meteorological and optical transmission data being collected at San Nicolas Island, categorized according to periods representing marine, continental or mixed aerosol sources. These data were based on a variety of sources. The aerosol source regions for the OSP III and CEWCOM-78 period were analyzed to perform such categorization. Based on the total

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integration of data, atmospheric conditions at San Nicolas Island during the CEWCOM/OSP period were marked by great variability.

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EXECUTIVE SUMMARY

"Marine/Continental History of Aerosols At San Nicolas Island During CEWCOM-78 and OSP III"

Basic Point: No matter where EOMET measurements are conducted, air mass sources must be determined using techniques like those employed by PACMISTESTCEN in order to interpret marine aerosol data and its implications for electrooptical systems. Air mass differences in aerosol distributions may be much more significant than localized differences due to small scale features or island terrain.

Specific Conclusions:

1. Air mass flow pattern analysis based on actual weather episodes is essential for interpretation of aerosol data and its application to E-O studies.

2. Techniques have been developed by PACMISTESTCEN for doing such analysis using satellite data, weather charts, conventional surface and meteorological profile data, and other data sources considered together.

3. These techniques are being applied to the data at San Nicolas Island to distinguish data taken under maritime conditions from those taken under continental effects.

4. Using these techniques, it was found that during the first two hi-mode measurement periods at San Nicolas (CEWCOM/OSP III and November 1978), considerably more continental influence was experienced than would be expected from long-term climatologies. These were separated by periods of strong maritime influence as expected. During EOMET-79, conditions were maritime much of the time. Measurements conducted at SNI during the winter rainy season, and during summer when low clouds are most frequent should show a higher incidence of maritime conditions since the previous hi-modes were all conducted during spring or fall transition months.

5. Even when air is of mixed origin, as in typical "coastal" environments, atmospheric and transmission data is quite useful because it applies to conditions in which many naval operations are conducted.

6. Some continental influence will likely be experienced at almost any oceanic site of operational relevance, but it is especially likely at American and European mainland coastal sites which are subject to contamination by fresh or aged pollution from local, or remote sources.

TP-79-32

PACIFIC MISSILE TEST CENTER
Point Mugu, California 93042

MARINE/CONTINENTAL HISTORY OF AEROSOLS AT SAN NICOLAS ISLAND DURING CEWCOM-78 AND OSP III

By

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and

V. R. Noonkester
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Meteorological and optical transmission data being collected at San Nicolas Island must be categorized according to time periods representing marine, continental, or mixed aerosol sources. Based on a variety of data from sources such as surface and upper-air charts, high-resolution ~~GOES~~ and DMSP satellite imagery, climatological data, hourly surface observations, automatic weather station observations, and rawinsonde data, the aerosol source regions for the OSP III and CEWCOM-78 data period were analyzed to perform such categorization. Techniques were developed for assimilating much of this information into summaries or indices which reveal the relative influence of maritime or continental conditions. Air trajectories from low-level winds and satellite cloud monitoring indicated complex circulation patterns making source region identification difficult at times. Some climatological and DMSP sea-surface temperature data were also useful in describing transition conditions in the lower atmosphere near San Nicolas Island. Based on the total integration of data, atmospheric conditions at San Nicolas Island during the CEWCOM/OSP period were marked by great variability, with several episodes of strong maritime influence being separated by periods of continental influence. These changing conditions were created by moving weather systems, with transition periods characterized by air of mixed origins.

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BACKGROUND

Tactical use of Navy weapon systems employing imaging, detection and other electro-optical (EO) sensors, require a predictable knowledge of their effectiveness under various weather conditions experienced over or near the world's oceans. Significant progress has been made by Selby, et al (1978), in developing transmission codes applicable to continental environments with modifications that apply in part to maritime environments. To measure the quality and quantity of atmospheric effects on propagation of energy in the visible, infrared, and ultraviolet parts of the spectrum under the Navy's "real-world" oceanic conditions, a Navy maritime site is required where such transmission conditions can be accurately measured using both laboratory and operational or near-operational systems.

Similarly, to develop Navy models with which specific effects on particular EO systems can be predicted or assessed under "real world" oceanic conditions, a Navy maritime site is also required where the marine atmosphere can be characterized in detail.

Under the joint sponsorship of the Navy's Electro-optical-Meteorology (EOMET) and Optical Signatures Programs (OSP), both of these objectives are being completed at San Nicolas Island (SNI) approximately 100 km off the coast of southern California (figure 1). SNI is part of the Pacific Missile Test Center (PACMISTESTCEN) and as such, is the focal point for Navy development, test and evaluation (DT&E) of missile, aircraft, and weapon systems. The north end of the island on the windward side provides three overwater transmission paths measuring 4.1, 2.5, and 1.6 km (figure 2). Details of this facility are described by Matthews, Williams, et al (1978).

ATMOSPHERIC CHARACTERIZATION AT SNI

SNI was selected as the Navy site for these efforts because it has the best overall combination of attributes which satisfy the requirements for a maritime atmospheric transmission facility. SNI is swept by prevailing northwest winds which have a long fetch across the north Pacific Ocean. With a climate typical of the Mediterranean, the island experiences a variety of weather conditions throughout the year ranging from Pacific storms, rain-bearing fronts, and changing airmasses during the cooler half of the year, to spatial and temporal variations in extensive stratus and low cloud cover during the warmer months. This results in a wide range of atmospheric transparencies as well as wind conditions.

SNI's proximity to the continent also permits air of continental origin to occasionally reach the island whenever winds blow from land to sea. Thus, in terms of meeting the Navy objectives at SNI, it is important to identify and distinguish those periods

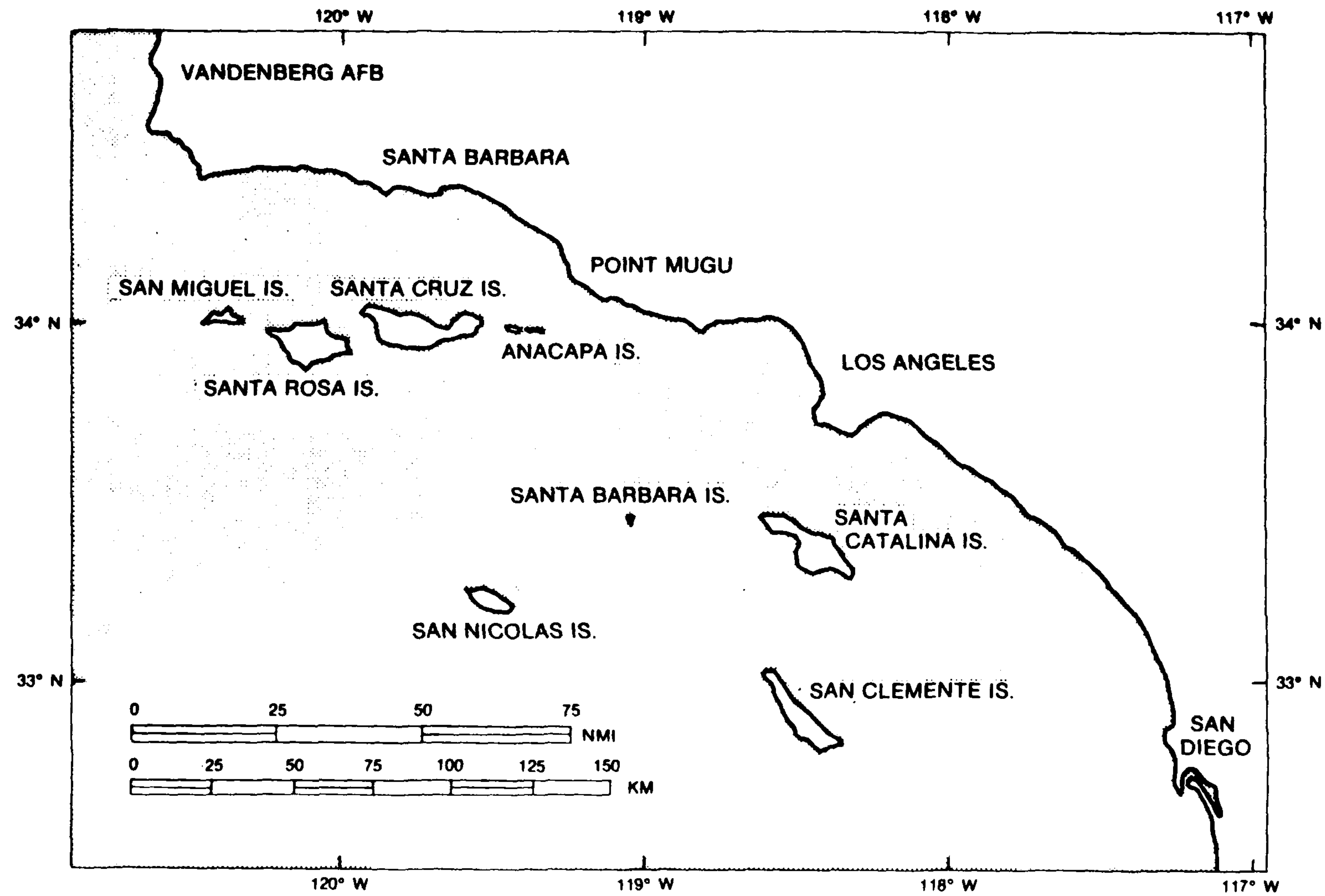


Figure 1. Southern California Coastline and Offshore Islands.

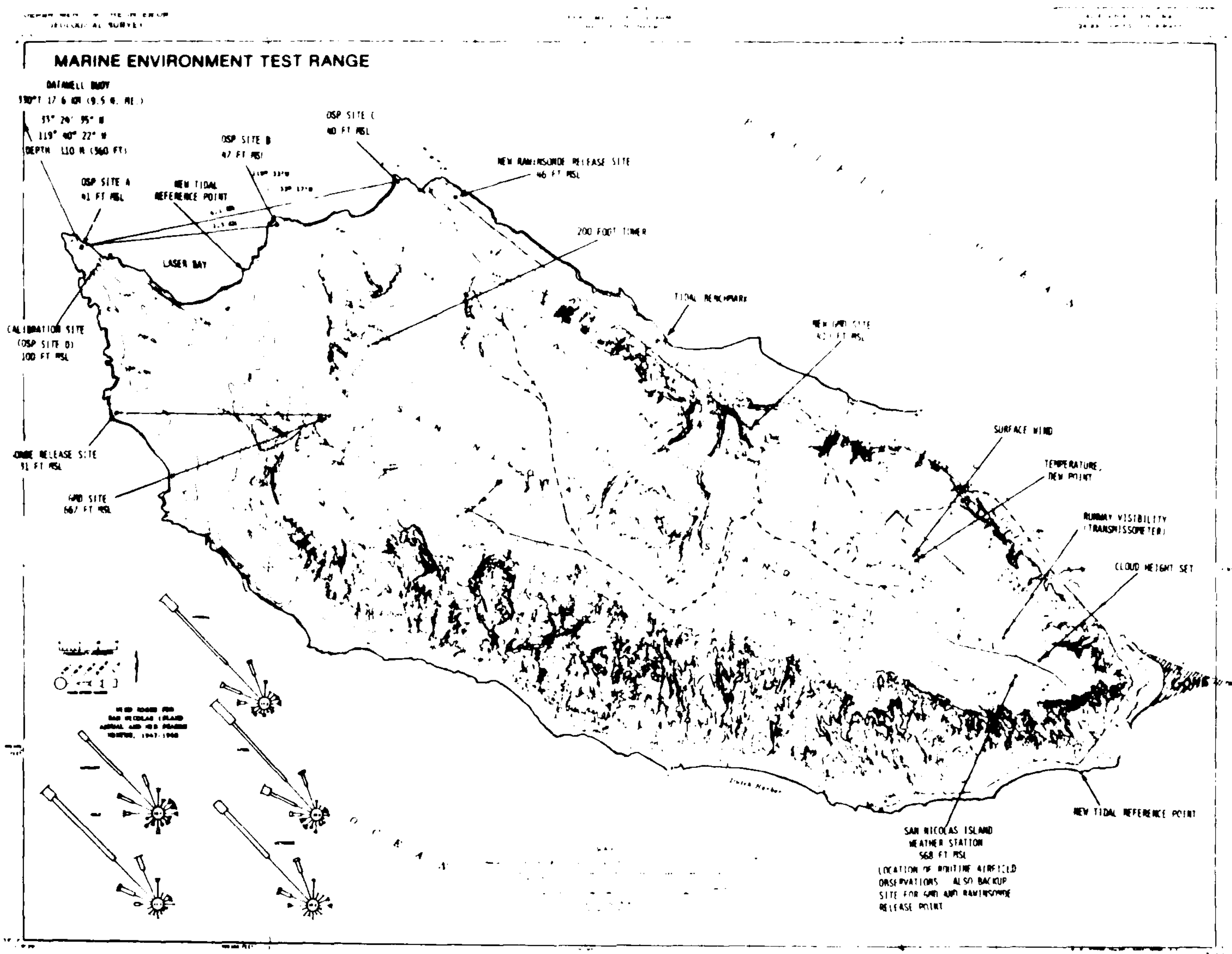


Figure 2. San Nicolas Island and the Marine Environment Test Range (METR)

when measurements are made at SNI under typically maritime conditions from those when measurements are made under continental or near continental conditions. Only in this way can the results of all measurements at an atmospheric transmission facility like SNI be correctly interpreted.

In characterizing the maritime atmosphere at SNI, it is necessary to concentrate on those elements or characteristics which have the greatest bearing on EO systems performance. These are aerosols, low-level stability, and moisture. At the SNI measurement sites, these parameters are being monitored along with winds, temperatures, and other important parameters by means of automatic weather stations, aerosol collectors, and supplemental sensors. These data are then used to interpret simultaneous transmission measurements across the overwater paths throughout the year.

During several "high-mode" periods and special experiments, detailed meteorological profile and surface measurements of aerosols and atmospheric structure are made from the Naval Research Laboratory's (NRL) Micrometeorological facility at the northern tip of the island (Blanc, 1978), from the Naval Ocean Systems Center's (NOSC) instrumented aircraft (Jensen, 1978), from PACMISTESTCEN's high-resolution rawinsonde soundings, and from many other participants cooperating in the Navy's effort. The first such major experiment at SNI was the Cooperative Experiment of West Coast Oceanography and Meteorology (CEWCOM-78), which generally coincided with a period of extensive target signature and background measurements known as Optical Signatures Program III (OSP III). The total period extended from 25 April to 1 June 1978.

Of all the parameters being measured, the size, distribution, and nature of aerosols are most important because of their scattering and absorption effects on energy. To determine the representativeness of aerosol conditions encountered at SNI to conditions over the open sea, and to correctly interpret the in-situ measurements, it is therefore necessary to determine the marine/continental history of air arriving at SNI. This was accomplished during CEWCOM-78/OSP III through an examination of the large scale flow patterns, wherein airmasses of various origins traverse the northeast Pacific or western North America with SNI in their path.

APPROACH

A wide variety of data from diverse sources were used in the analysis of aerosol history at SNI. These included individual and statistically summarized surface data, upper-air measurements, synoptic weather charts for the surface and higher levels, and high-resolution meteorological satellite imagery. These data sources are listed in table 1.

Table 1. Data Sources Used to Determine Aerosol History at SNI During CEWCOM/OSP III

Surface
Winds, temperature, humidity, visibility, and cloud cover at Sites A, B, and C
Winds, temperature, humidity, visibility, and cloud cover at SNI Airfield
Winds, temperature, humidity, visibility, and cloud cover at Mainland Coastal Sites
Winds, temperature, humidity, visibility, and cloud cover at Island Sites
Marine climatologies of cloud cover, visibility, and sea surface temperature
Climatology of winds from SNI Airfield
National Meteorological Center (NMC) Surface Weather Charts
NRL radon measurements at SNI and aboard NPS Vessel ACANIA
Visual observations at SNI
Upper-Air
National Meteorological Center (NMC) Upper-Air Charts at 850, 700, and 500 mb.
Fleet Numerical Weather Central (FNWC) Upper-Air Charts for 500 mb
GOES Satellite imagery of North Pacific and southern California areas at 30 minute intervals
DMSP Satellite imagery
PACMISTESTCEN rawinsonde measurements at SNI and Point Mugu
Laguna Peak (1,400 feet msl) wind observations

First, surface weather parameters measured during CEWCOM/OSP III were compared with long term climatologies developed by PACMISTESTCEN for the SNI airfield. These comparisons indicated a higher incidence of continental flow for this time of year, overall, than is climatologically expected. Climatological mixing conditions were also inferred which portray the month of May at SNI as a general month of transition.

Next, a comprehensive analysis of meteorological conditions affecting SNI was made for each day of the CEWCOM/OSP III period. This detailed examination later permitted the separation or partition of the measurement period into episodes of maritime, continental, or mixed aerosol history. For each day, synoptic charts and satellite imagery were used to describe the prevailing large scale (synoptic) weather situation affecting SNI. This included the identification of major airmasses, cloud features and coverage, cold fronts, and moving large scale waves (100 - 1,000 mi) which determine SNI weather.

Next surface pressure gradients were calculated between west-east and north-south stations on the mainland, and used as indices of whether the air was flowing from the sea to the land (maritime at SNI) or from the land to the sea (continental at SNI).

Then, indications of vertical transport were considered using time sections of inversion height deduced from rawinsonde data. These were supplemented with important inferrences on low-level vertical mixing conditions based on wind observations and DMSP-derived sea surface temperature patterns.

Lastly, horizontal transport conditions were analyzed. This involved principally, the construction and determination of low-level air trajectories ending at SNI for selected days. Two techniques of trajectory analysis were utilized. One involved trajectory computations in the customary manner, using hourly wind observations from coastal and island locations. Based on constructed streamline patterns, air displacements were calculated for hourly intervals extrapolated backward in time from northern SNI as a starting point. The second trajectory method employed cloud motion vectors or displacements for low (marine layer) cloud elements, determined from 16 mm film loops of GOES high resolution satellite imagery. Coverage over the area of interest was at 30 minute intervals showing movements of specific cloud elements or clusters.

Each of the two trajectory techniques has both strong points and weak points. They sometimes produce different trajectories since they are based on different data sources and slightly different altitudes. To aid in the determination of horizontal transport conditions, horizontal visibility analyses (used as an airmass tracer), Laguna Peak wind observations, surface radon measurements (Larson et al, 1979), and visual weather observations (Jeck, 1979, and Fairall et al, 1979), were also employed. When used with the aforementioned analyses of vertical transport, pressure gradients and synoptic weather conditions, a relatively confident determination of maritime versus continental aerosol history over the period of from one to several days could be made for each day of CEWCOM/OSP III at SNI. However, regions of strong subsidence introduced complications to the analysis by bringing air of uncertain origins from high- to low-levels.

EXAMPLE OF ANALYSES: 10 MAY 1978

To illustrate the techniques used in this effort, some results for 10 May 1978 are presented. This was determined to be a day of predominantly maritime conditions at SNI, and most of the data products were available for analysis.

Synoptic Situation

On this day, a strong Pacific anticyclone was located west of California with a general northwesterly flow along the west coast and at SNI. Weakening frontal systems moved towards SNI from the northwest across the top of the Pacific High. The locations of these features are shown in figure 3. The widespread cellular low stratus clouds over the eastern Pacific (near and to the west of SNI) and the weakening frontal cloud band advancing from the northwest are visible in the GOES picture in figure 4. A more detailed view of the stratus cover and its proximity to SNI is shown in the DMSP visual imagery presented as figure 5. This picture shows wave phenomena which reveal the northwest, maritime flow at SNI and daytime clearing to the north and east of SNI.

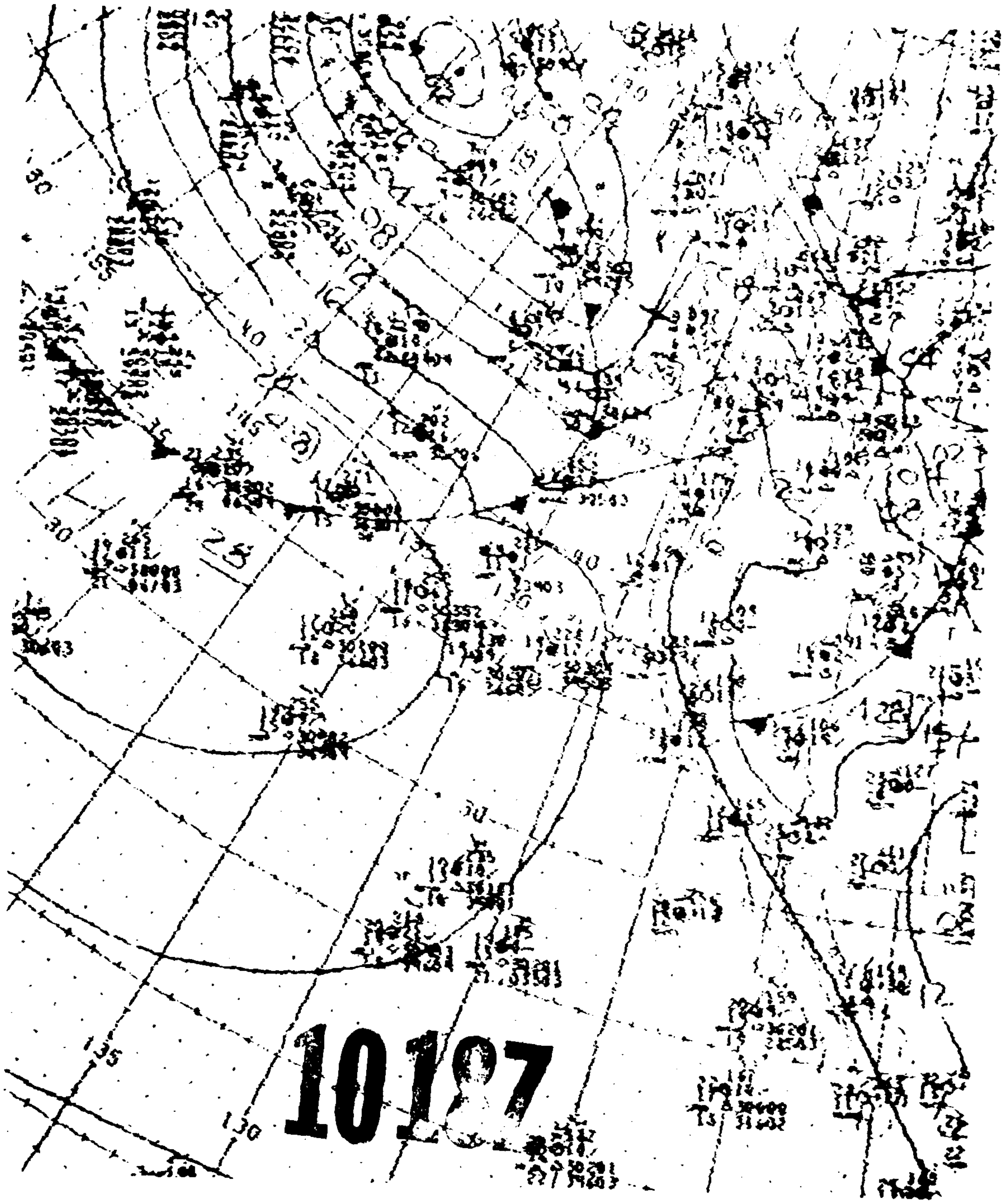
Based on filmloops of GOES imagery for the entire north Pacific ocean area, a composite analysis of cloud systems and derived flow patterns is provided in figure 6. This composite covers the period from the afternoon of 9 May through the morning of 10 May. It shows the northwest flow and stratus near the west coast, the front moving into the Pacific Northwest, and other higher-altitude features of less interest.

Local Pressure Gradients - An Index of Maritime/Continental Influence

Using surface pressure gradients between San Francisco and Point Mugu (SFO-NTD), Bakersfield and Point Mugu (BFL-NTD), and Tonopah, Nevada and Los Angeles (TPH-LAX), a measure of the tendency for sea to land (maritime) or land to sea (continental) airflow can be inferred. When the pressure differences are negative (higher pressure to the south and west), the tendency for a northwesterly maritime flow at SNI is greatest. The larger the negative value, the greater the maritime tendency and vice versa. As can be seen in the time sections of pressure gradient indices in figure 7, 10 May is a period when two of the three indices are strongly negative and the third reaches zero. In this figure, 10 May is at the center of one of two periods of maritime flow at SNI (the other is centered around 14 and 15 May and are separated by periods of continental or mixed air).

Vertical Transport

To determine the vertical transport conditions in the general vicinity of SNI on 10 May, a time section of inversion height is shown in figure 8 for the period 8 to 12 May based on SNI rawinsonde data. Stability is greatest where isentropes are horizontal and closely packed in the warm inversion layer. This region separates well mixed marine air below within the marine layer from drier (possibly continental) air above. When the marine layer is thick and the inversion strong, little chance exists for continental aerosols mixing down to the surface at SNI. These conditions existed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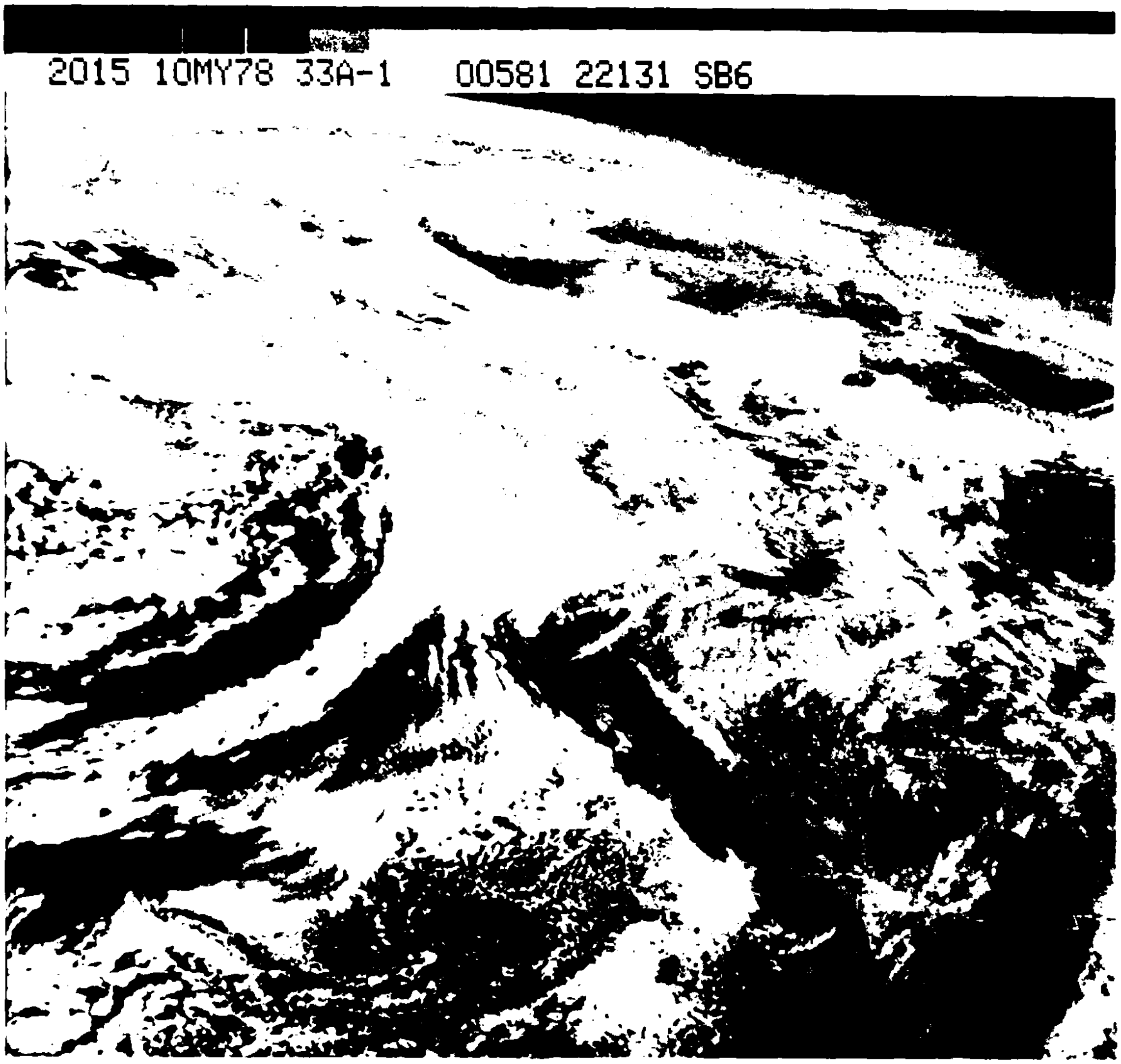


Figure 4. GOES Satellite Imagery of 2015Z (1215 PST) 10 May 1978, Showing Widespread Cellular Stratus and Frontal Band Off West Coast.

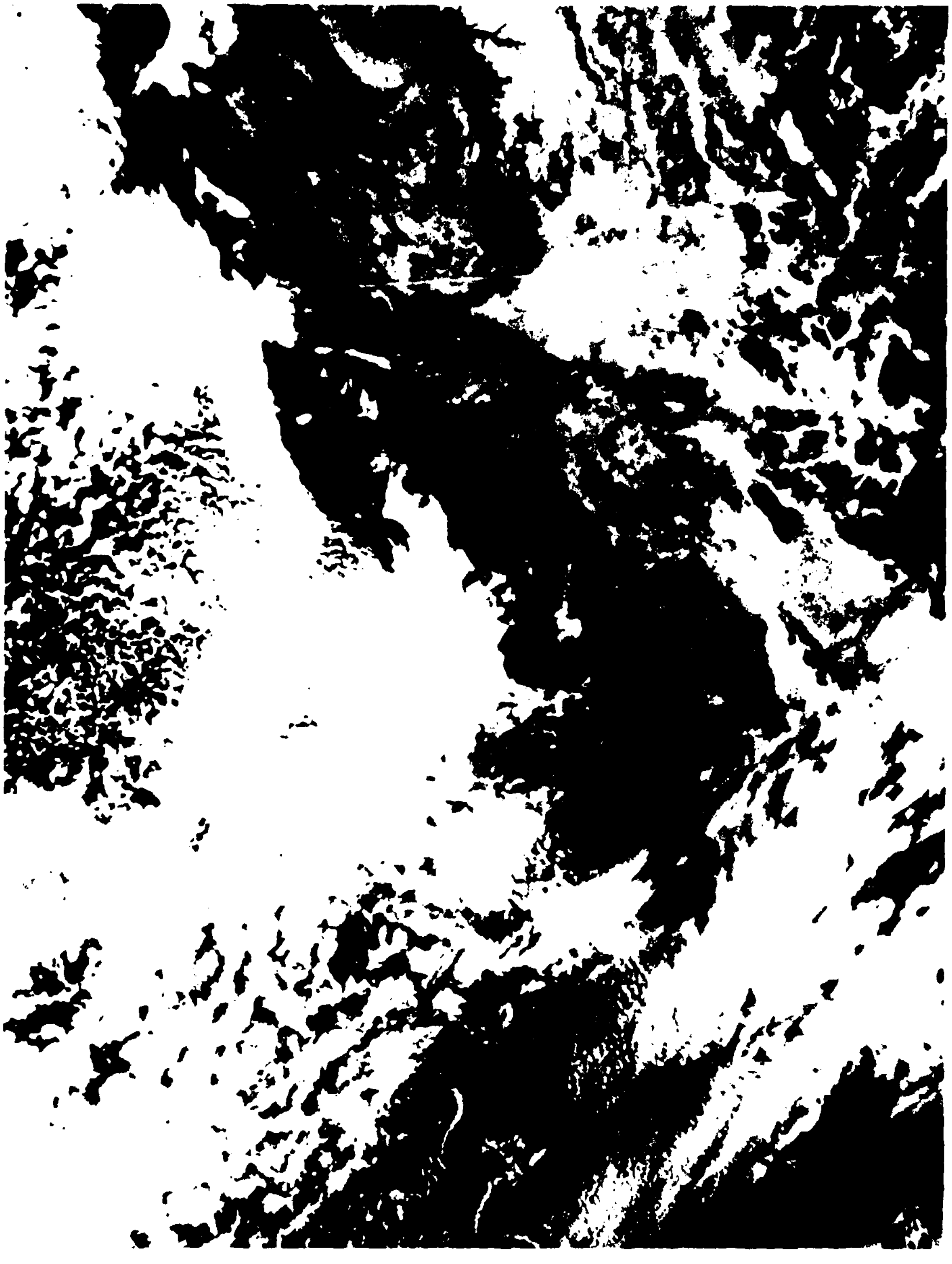


Figure 5. DMSP Satellite Imagery at 1917Z (1117 PST), 10 May 1978 Showing Extensive Stratus and Gravity Wave-induced Clearing Southeast of SNI.

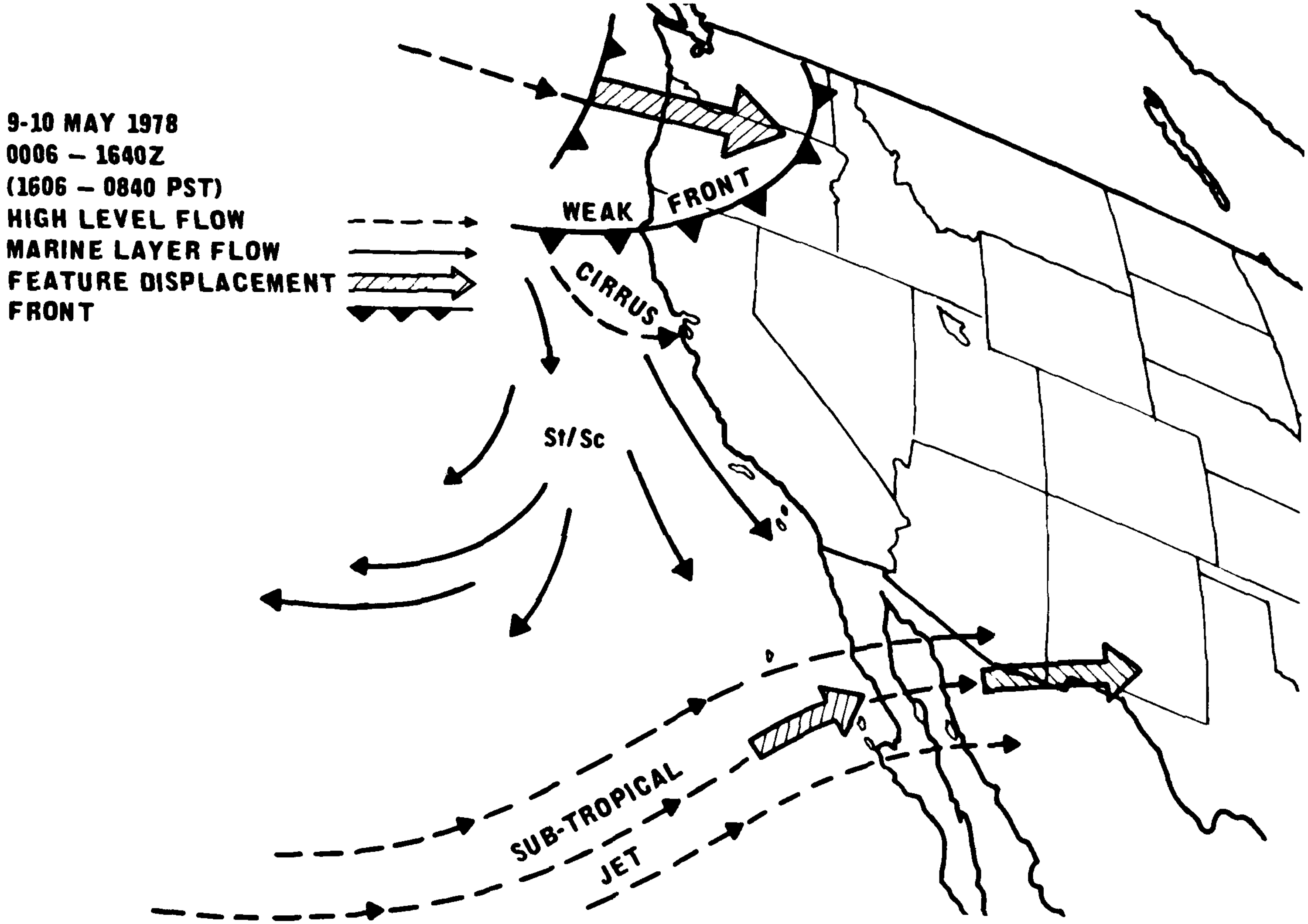
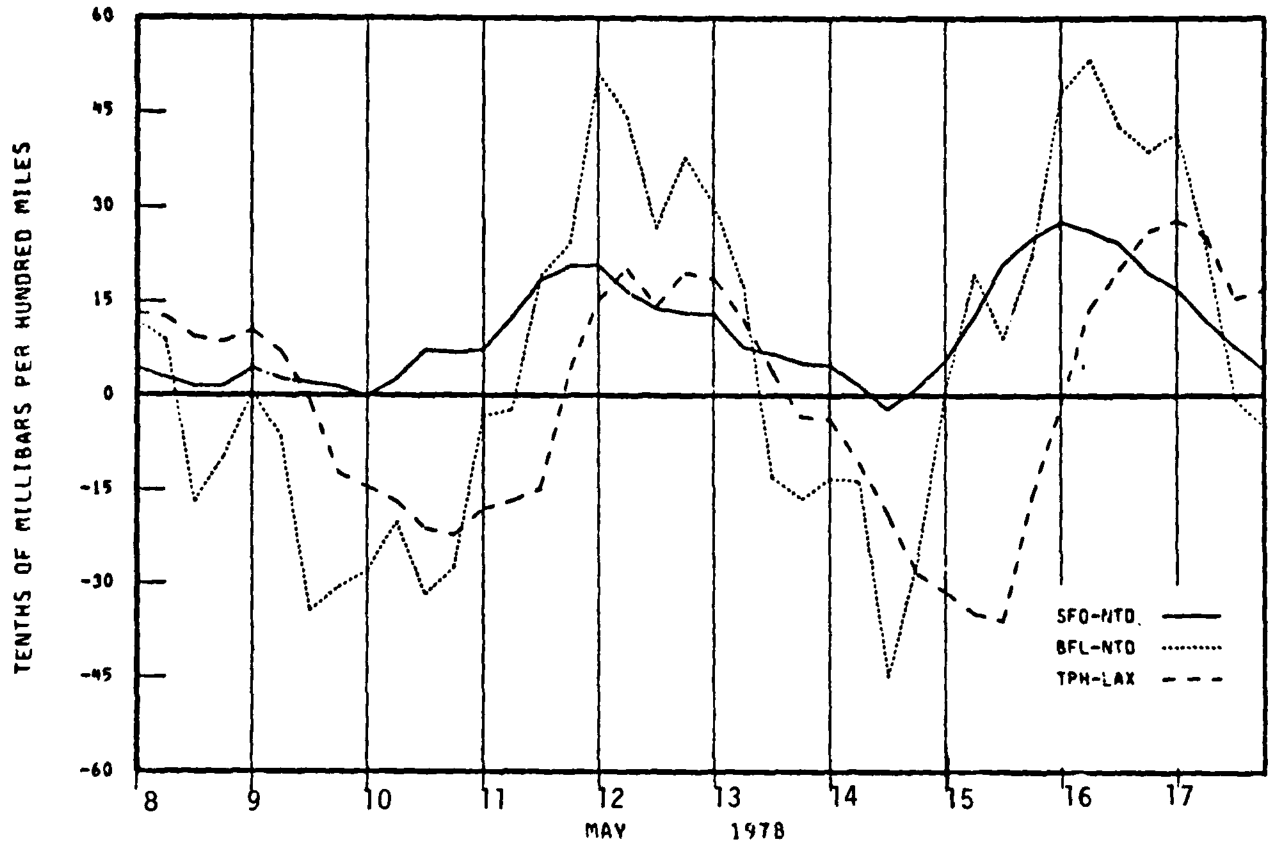


Figure 6. Air Mass Flow Patterns Over Pacific Ocean Inferred from GOES Film Loops, 0006 - 1640Z, 10 May 1978.



Dates centered at 12Z (0400 PST)

Figure 7. Surface Pressure Gradients During CEWCOM, 8 to 17 May 1978.

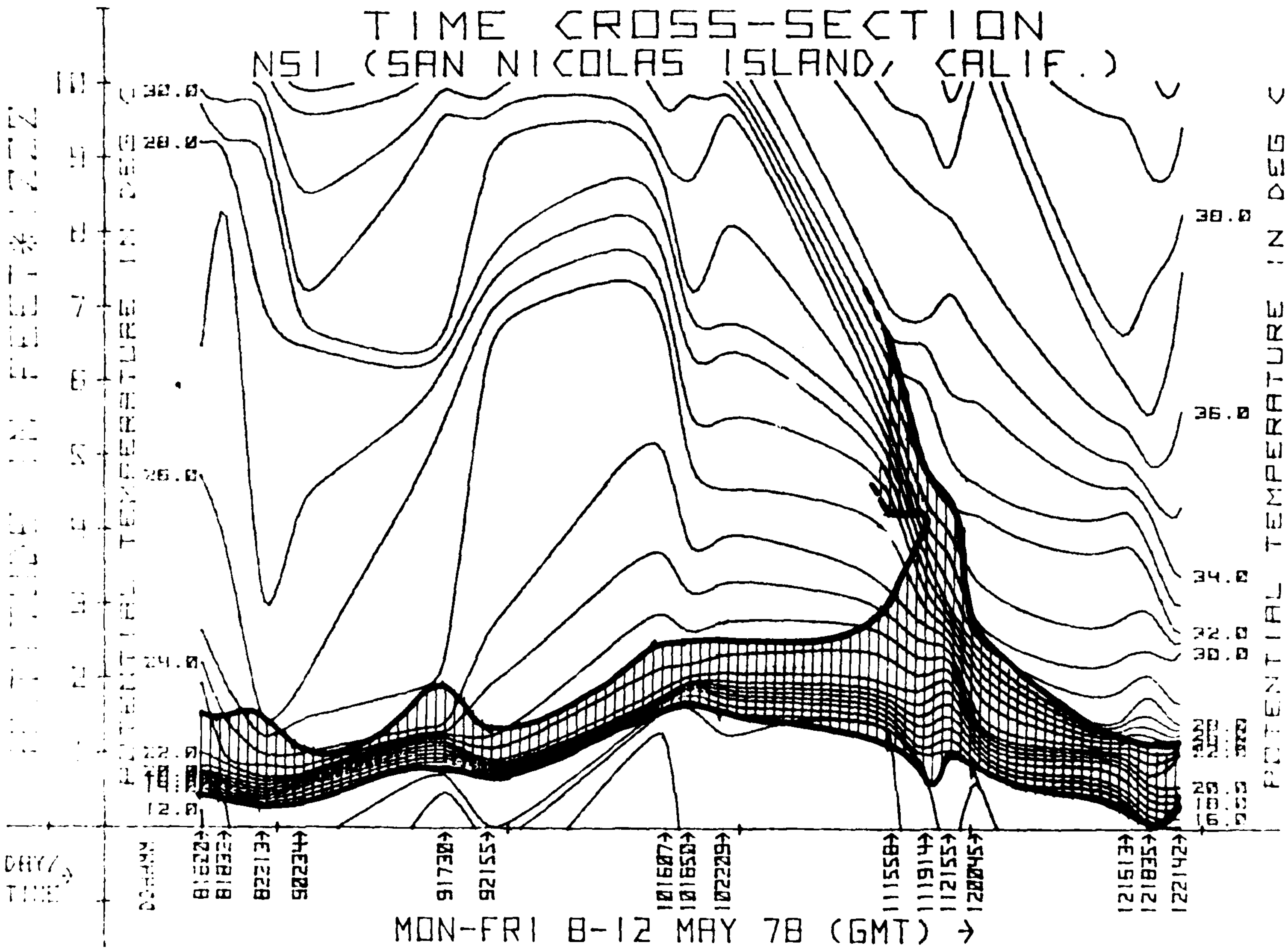


Figure 8. Time Cross-Section of Inversion Height (Shaded Region) Based on SNI Rawinsondes from 8 to 12 May 1978. (Thin Black Lines are Isentropes. Sounding Times (GMT) are Indicated at Bottom.)

at SNI on 10 May when the marine layer reached a maximum depth of about 1,500 feet. While downward mixing of dry air cannot be precluded far at sea, such air seldom reaches the surface, and would almost certainly assume marine characteristics prior to reaching SNI.

Vertical mixing conditions near SNI can also be inferred by considering the effect of the wind flow superimposed on sea surface temperature patterns. Based on sea surface temperatures analyzed from DMSP infrared imagery on 11 May (figure 9), and assuming that these conditions existed on 10 May as well, SNI is shown to be located just to the west of a region of sharp sea surface temperature contrast separating cool water to the west from warmer water to the east. Such temperature gradients can have an important influence on stability and vertical mixing and therefore on the aerosol size distribution at SNI. On 10 May, since the wind at SNI is from the northwest, any such mixing effects are more likely to be east (downwind) of SNI than at the island itself, so that SNI conditions are relatively representative of conditions further out to sea (upwind to the west).

Horizontal Transport

Trajectories were constructed for 10 May from both surface wind reports (near sea level) and cloud motion vectors (within the marine layer). Figure 10 shows a 5-1/2 hour daytime trajectory, based on wind observations which show an over-water path to SNI with a possible transit over the Point Conception land area prior to entering the starting point of the trajectory. The trajectory also crosses the eastern edge of Santa Rosa Island.

However, the path of marine-layer cloud elements, as seen by satellite (figure 11), indicates an entirely over-ocean trajectory for a slightly longer time period. Also visible in figure 11, are streamlines (thin black arrows) and a second longer trajectory (due to stronger winds) further to the northwest which is in agreement with the general northwest maritime flow concluded to be present at SNI on this day. It should be pointed out that while trajectories of 5 to 10 hours duration may not in themselves be sufficient to determine aerosol or airmass history, continuity and careful monitoring of synoptic factors did permit air source characteristics to be confidently extrapolated further backwards in time in most instances.

One further indication of maritime conditions at SNI on 10 May is provided by an analysis of visibility conditions during mid-morning (figure 12). While such analyses are most questionable over ocean areas due to data voids, careful examination of winds, prevailing visibility, temperature, dewpoints, and hour-to-hour variations permits a reasonable delineation of low visibility areas (due to smog) from high visibility areas (due to clean air of either marine or continental origin), according to wind direction and geographical location. In figure 12, high visibilities within the marine layer are concluded to indicate clean marine air at SNI.

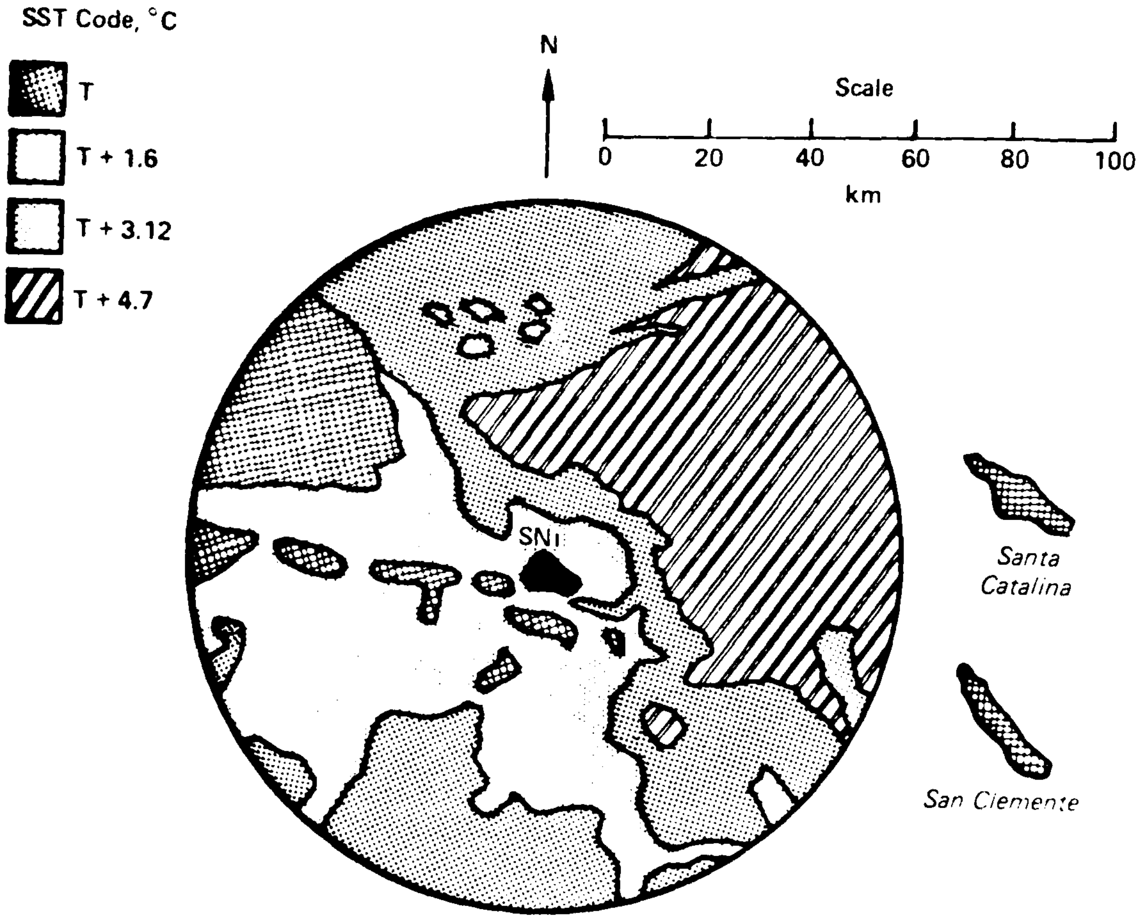


Figure 9. Sea Surface Temperature Pattern Based on DMSP Infrared Data, 1947 PST, 11 May 1978.

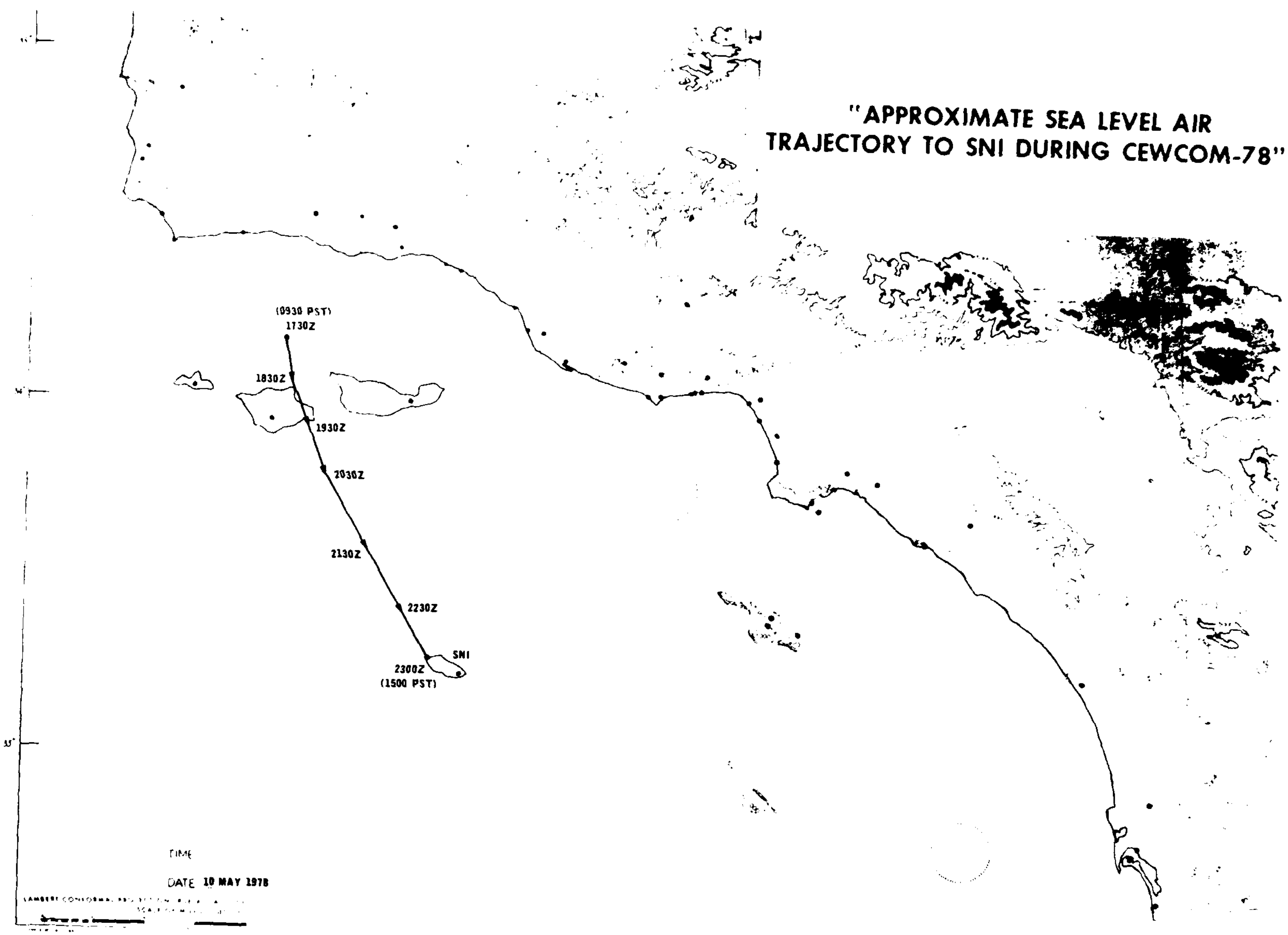


Figure 10. Approximate Sea Level Air Trajectory to SNI During CEWCOM-78, 10 May 1978.

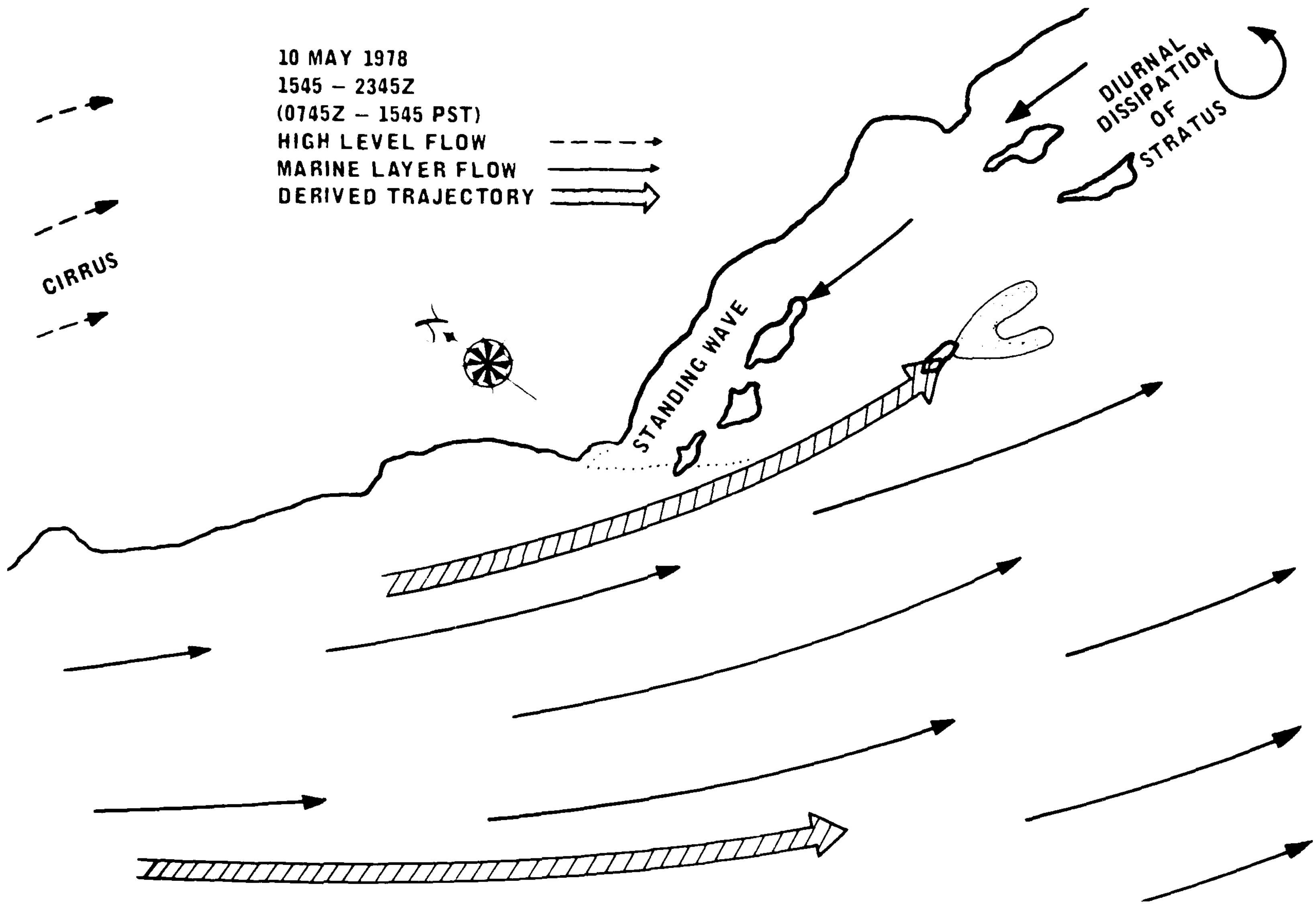


Figure 11. Marine Layer Trajectories and Flow Patterns Derived from GOES Satellite Film Loops, 10 May 1978.

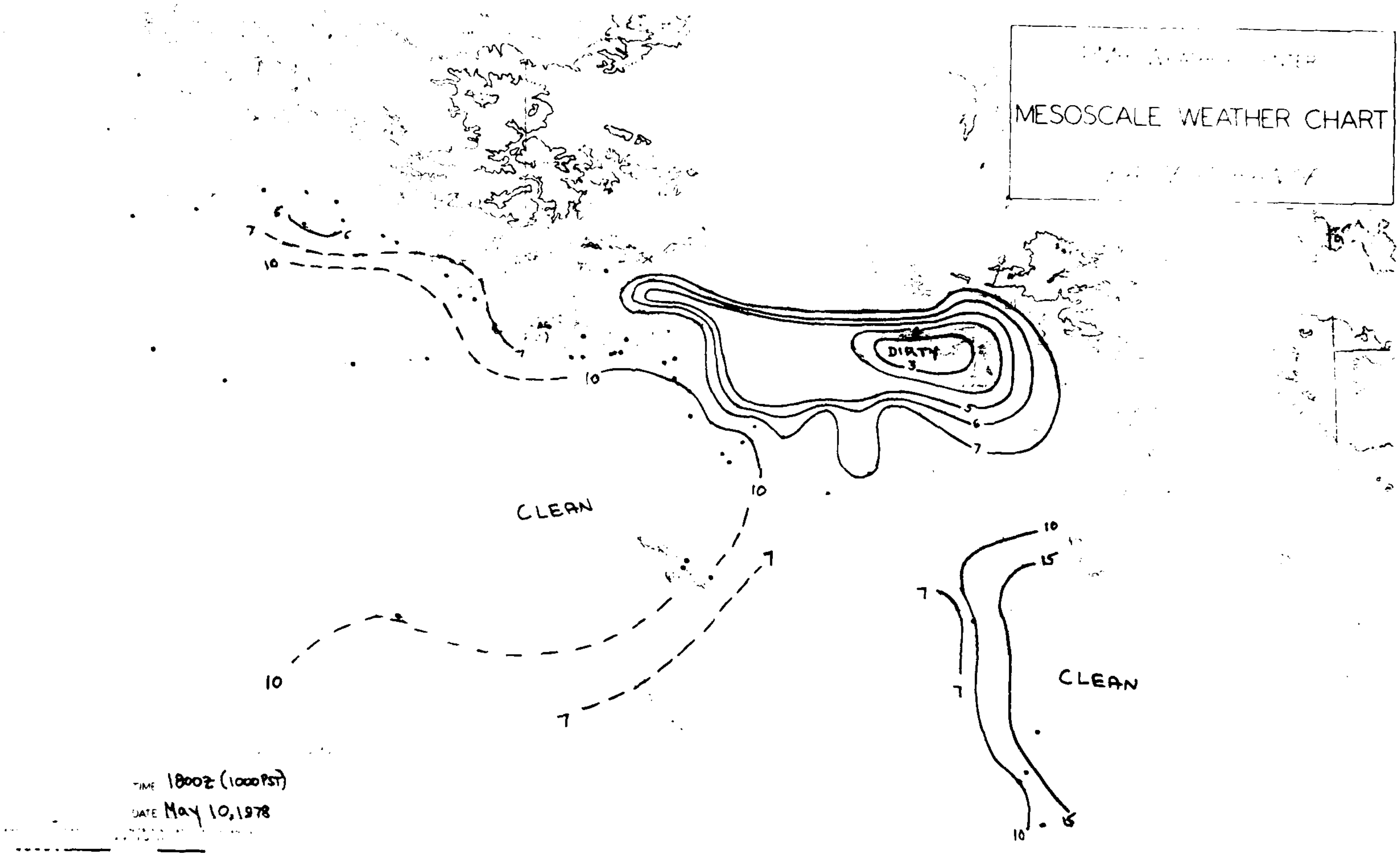


Figure 12. Analysis of Visibility Patterns Over Coastal Southern California for 1800Z, 10 May 1978.

Additional support for maritime airflow at SNI is available from radon measurements provided by NRL, which indicate very low values on 10 May (Jeck, 1979 and Larson et al, 1979).

SUMMARY/CONCLUSIONS

The complete report summarizes the principal aerosol source regions for SNI during the five-week CEWCOM-78 and OSP III measurement periods (although, only analyses for 10 May 1978 appear in this summary report). It includes detailed day-by-day analyses of the meteorological features and processes responsible for aerosol transport to the island based on a variety of data sources such as surface and upper-air charts, high-resolution GOES and DMSP (satellite) imagery, climatological data, hourly surface observations, automatic weather station observations, rawinsonde data, information measured or recorded at the PACMISTESTCEN and other Navy sources.

Techniques were developed for assimilating much of this information into time cross-section analyses of inversion base height, marine layer conditions, indices of maritime/continental influence, and, most significantly, short-period trajectory analyses to describe or infer the vertical and horizontal transport of aerosols near SNI.

Based on these studies, it was found that the circulation controlling the airflow at SNI during CEWCOM-78/OSP was highly variable with a higher occurrence of offshore (continental) flow than expected based on long-term climatology. Several episodes of strong maritime flow were observed at SNI separated by periods when the air transport to SNI was from the land to sea or continental. These changes were controlled by moving weather systems separated by several days, comprising both synoptic and mesoscale circulations. The transition from one flow pattern to the other was sometimes rapid and there were days when air arriving at SNI had a mixed maritime and continental origin. Table 2 provides a breakdown of conditions during CEWCOM-78/OSP into periods of maritime and continental aerosol history at SNI.

Table 2. CEWCOM-78/OSP III Periods of Marine/Continental Influence at San Nicolas Island

Marine Influence	Continental Influence	Mixed, Modified, or Transition
25 -27 April	4 May	28 - 30 April
1 - 3 May	11 - 12 May	5 - 7 May
8 -10 May	17 - 18 May	13 May
14 -15 May	26 - 29 May	16 May
19 -24 May		25 May
30 May- 1 June		

Since the measurement period occurred during a month of transition from winter to summer with greater than normal offshore flow and variability in weather, and since aerosol loading at SNI may be affected by underlying gradients of sea surface temperature common to coastal regions, data taken at SNI during the CEWCOM-78/OSP period were at times not representative of open-ocean conditions likely to be found at much greater distances westward from SNI. However, meteorological analyses performed during this period, and observations made in other regions around the world show that during periods of large-scale offshore flow, effects on the marine layer may be observed hundreds of miles out into the open-ocean, so that the airflow at great distances from land are often affected. Thus, under strong offshore flow, conditions at SNI might still approximate some conditions experienced far at sea. During the periods of onshore maritime flow observed during CEWCOM/OSP, data taken at SNI are likely to be substantially representative of open-ocean conditions.

In attempting to delineate the relative influence of maritime or continental effects on aerosols at SNI, two types of trajectory analysis were used, one based on surface wind reports and the other upon satellite-derived cloud motion vectors. Due to data voids and inherent limitations of both techniques, conclusions on source regions did not always agree. To increase the accuracy, and reduce the effort required in this analysis for future measurement periods, techniques are being developed to automate the trajectory analysis process and integrate a variety of data sources into a single product. Thus, techniques can be applied to identify and describe low-level aerosol source regions at a maritime measurement site based on a variety of conventional weather data, satellite observations, in-situ measurements, and calculator-graphical techniques. These can be imperfectly applied to determine the relative maritime/continental influence at the site in question.

IMPLICATIONS FOR THE REPRESENTATIVENESS OF A MARITIME SITE

It should be emphasized that the maritime/continental nature of an ocean site cannot be established solely from geographical considerations and statistical climatologies of surface wind directions. Airmass flow pattern analysis (in 3-dimensions if possible) based on actual synoptic/mesoscale episodes and trajectory analysis is essential. Also of importance to establish the maritime/continental influence at an ocean site is the consideration of many other available parameters, conditions, or indices which are commonly used to described an air parcel source. These include moisture, wind direction and speed, cloud cover, air source, and length of over-water/over-land trajectory, sea surface temperature patterns as it affects mixing, chemical composition, tracers (radon), aerosol distributions and their vertical profiles, and conditions aloft, as a function of season.

A volume of air is always undergoing modification from above and below as it moves across the Earth's surface; some of these subtle airmass changes may not be indicated by surface winds. Because of these horizontal and vertical transport mechanisms and slow airmass modification, "pure" marine or continental characteristics will seldom be found, even over the middle of the oceans and deserts; instead various degrees of transition and relative marine/continental nature will prevail. Also an EO system performance analysis cannot be based solely on considerations of marine/continental airflow; important mesoscale variations in humidity and wind structure often noted in satellite data must also be considered.

The question of suitability of SNI as a Navy site for EO studies in a maritime environment cannot be answered directly from an analysis of CEWCOM/OSP data. It has been pointed out that this period was marked by large fluctuations between marine and continental airmasses. Subsequent measurements made during November 1978 also show continental contributions, but measurements during April/May 1979 indicated a higher persistency of maritime conditions at SNI. Since all three measurement periods occurred during the transition seasons of spring or fall, an even higher incidence of maritime conditions can be expected for measurements conducted in winter when Pacific storms are most frequent, or during summer when stable marine layer conditions are nearly a daily occurrence at SNI. It appears that SNI is a good approximation to an open-ocean environment during periods of strong or persistent maritime flow, and unrepresentative of an open-ocean environment during periods of strong offshore flow. In between or during periods of transition conditions, SNI may be representative of a coastal environment, - an environment where many Naval operations are typically conducted. SNI appears to be distinctly more maritime than would be encountered on a populated mainland coast or larger island, particularly when compared with American and European coastline locations which are heavily contaminated by fresh and aged urban pollution.

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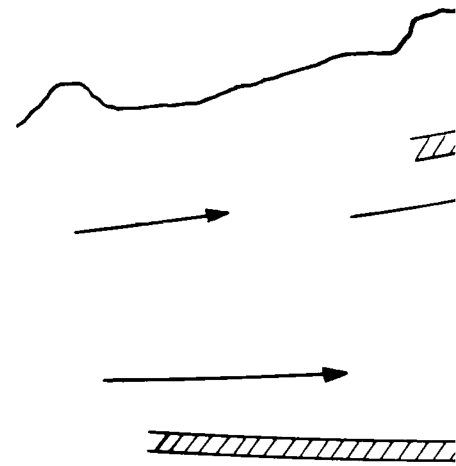

Figure 11. Marine Layer Trajecto